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(57) Abstract

A highly stable liquid formulation having broad spectrum preservative properties which constitutes an admixture of a dialkanol–substituted DMH, an iodopropynyl compound, a stabilizer of a hydantoin, urea or derivative thereof, and a hydroxyl solvent. Preferably the constituents are dimethyloldimethylhydantoin, 3–iodo–2–propynylbutyl carbamate, dimethylhydantoin, and a glycol solvent. The preservative preferably has a total formaldehyde content of 5 % and less than 0.2 % of free formaldehyde. The composition is prepared by successively admixing the dialkanol–substituted dimethylhydantoin and the stabilizer, the hydroxyl solvent, and the iodopropynyl compound. Also described is a stabilized iodopropynyl compound preferably containing dimethylhydantoin as the stabilizer.

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STABILIZED MIXTURES OF AN IODOPROPARGYL COMPOUND AND A FORMALDEHYDE DONOR

Background of the Invention

The need for effective and economical preservative compositions is well known. There are a wide variety of applications where inhibiting the growth of microorganisms is necessary, as for example personal care products such as shampoos, creams, lotions, cosmetics, soap and household products such as laundry detergents, hard surface cleaners, and fabric softeners. The shelf life of these preparations depends on their resistance to microbial spoilage.

In addition, in many industrial applications, antimicrobial agents are useful in paint, wood, textiles, adhesives, sealants, leather, rope, paper pulp, plastics, fuel, oil, and rubber and metal working fluids. The control of slime-producing bacteria and fungi in pulp and paper mills and cooling towers is a matter of substantial commercial importance.

For the foregoing applications the demand for stable broad-spectrum preservatives has increased. In recent years, these needs have been met with solid formulations. For example, combinations of formaldehyde donors (e.g., dimethyloldimethylhydantoin (DMDMH)) and halopropynyl compounds (e.g., 3-iodo-2-propynylbutyl carbamate (IPBC)) have achieved considerable commercial success. Such synergistic combinations have been described in U.S. Patent 4,844,891.

Furthermore, because of the demand of governmental regulations, low free-formaldehyde products are needed. Research in this area has also proved beneficial. For example, in the case of DMDMH, improved formulation and

processing has resulted in compositions which contain less than 0.1% free formaldehyde. (See U.S. Patent 5,405,862.) In contrast, earlier formulations of DMDMH had over 1% of free formaldehyde. (See U.S. Patent 3,987,184.)

At the present time, in addition to meeting the above criteria, the industry is demanding liquid forms of preservatives as the use of automatic liquid blending systems becomes more popular. Unfortunately, preservatives that are in liquid form, highly stable, broad spectrum, and low in free formaldehyde have eluded formulators.

Summary of the Invention

It has now been discovered that highly stable, liquid formulations of broad spectrum preservatives can be prepared by admixing alkanol-substituted dimethylhydantoins, iodopropynyl compounds, stabilizers, and a solvent. This invention is based, in part, on the unexpected finding that the iodopropynyl compounds can be stabilized at high temperatures by the addition of hydantoin-type stabilizers such as dimethylhydantoin. Furthermore, the compositions of the invention have surprisingly good physical stability at low temperatures and enhanced solubility which allows the easy preparation of these highly concentrated mixtures. Such highly concentrated preservatives useful in automatic liquid blending systems could not heretofore be prepared.

Brief Description of the Figures

Figure 1 illustrates the results of a 48 hour minimum inhibitory concentration test against 8 bacteria organisms of the liquid formulation of the invention and a solid formulation of DMDMH and IPBC.

Figure 2 illustrates the results of a 72 hour minimum inhibitory concentration test against 4 fungal organisms of the liquid formulation of the invention and a solid formulation of DMDMH and IPBC.

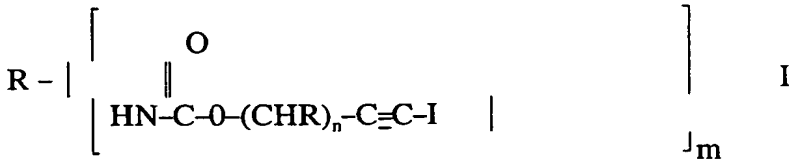
Detailed Description of the Invention

	Broad wt.%	Preferred wt.%
Dialkanol-substituted DMH	20-95%	75-85%
Iodopropynyl Compound	0.2-20	1-5
Stabilizer	1-30	5-20
Hydroxyl Solvent	0-60	2-20

The ratio of the stabilizer to the iodopropynyl compound may broadly be from about 150:1 to 0.05:1, preferably from 20:1 to 1:1, most desirably from about 10:1 to 2:1.

The alkanol-substituted DMH compounds used in the invention are well known and include those defined in U.S. Patent Nos. 3,987,184 and 4,172,140, the entire contents of which are incorporated herein by reference. These are condensation products of 5,5-dimethylhydantoin with 1, 2, or more moles of formaldehyde (e.g., 1,3-dimethylol-5,5-dimethylhydantoin, 1-methylol-5,5-dimethylhydantoin, or 3-methylol-5,5-dimethylhydantoin, 1,3-dimethylol-oxymethylene-5,5-dimethylhydantoin, 1-methylol-3-methyloloxymethylene-5,5-dimethylhydantoin and 1,3-dimethyloloxymethylene-5,5-dimethylhydantoin, and mixtures thereof).

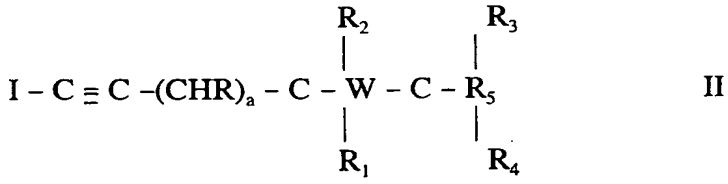
Examples of compounds which may be used as the iodopropynyl component of the invention are the fungicidally active iodopropynyl derivatives. These include compounds derived from propynyl or iodopropynyl alcohols such as the esters, ethers, acetals, carbamates and carbonates and the iodopropynyl derivatives of pyrimidines, triazolinones, tetrazoles, triazinones, sulfamides, benzothiazoles, ammonium salts, carboxamides, hydroxamates, and ureas. Preferred among these compounds is 3-iodo-2-propynylbutyl carbamate, IPBC. These compounds are included within the broadly useful class of compounds having the generic formulas such as I and II shown below:



wherein:

R is selected from the group consisting of substituted and unsubstituted alkyl, aryl, and alkylaryl groups having from 1 to 20 carbon atoms; and

m and n are independent integers from 1 to 3.



wherein:

R_1 and R_2 are defined as R_3 and R_4 below or are joined to form a cycloalkyl, cycloalkenyl, aromatic or a heterocyclic ring containing an oxygen, nitrogen or sulfur atom or an alkoxy, amino, carbonyl, carboxyl, halo, hydroxyl, keto or a thiocarboxyl-substituted derivative thereof;

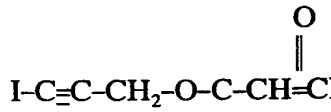
R_3, R_4 and R_5 are independently selected from (A) hydrogen, alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl, a heterocyclic ring containing an oxygen, nitrogen or sulfur atom, alkoxy, amino, carbonyl, carboxyl, halo, hydroxyl, keto or a thiocarboxyl and (B) substituted derivatives of the alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl and the heterocyclic ring wherein the substitutions are alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl, alkoxy, amino, carboxyl, halo, hydroxyl, keto or a thiocarboxyl;

a is 0 to 16;

W may be a single bond, oxygen, NR_6, or $(CR_7R_8)_m$, wherein R_6 is hydrogen, alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl or a heterocyclic ring containing an oxygen, nitrogen or sulfur atom or a substituted derivative of alkyl, cycloalkyl, alkenyl, cycloalkenyl or aryl groups wherein the substitutions are alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl, alkoxy, amino, carbonyl, carboxyl, halo, hydroxyl, keto, or a thiocarboxyl wherein R_6, R_7 and R_8 are defined as R_3 and R_4 above and m is an integer from 1 to 12. The above definition of R_6 includes, among other things, an aminoalkyl group.

The heterocyclic rings referred to in the above definitions may contain from 5 to 8 members, the alkyl or cycloalkyl groups from 1 to 18 atoms, the alkenyl or cycloalkenyl groups from 2 to 18 carbon atoms, and the aryl groups from 6 to 10 members.

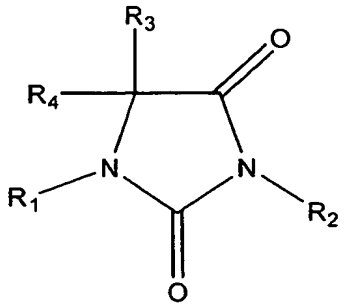
In formula II, when R_1 and R_2 are hydrogen, R_3 and R_4 are carbonyl, R_5 is -CH=CH-CO_2H; a is equal to 0; and W is oxygen, the compound is iodopropynyl maleate,



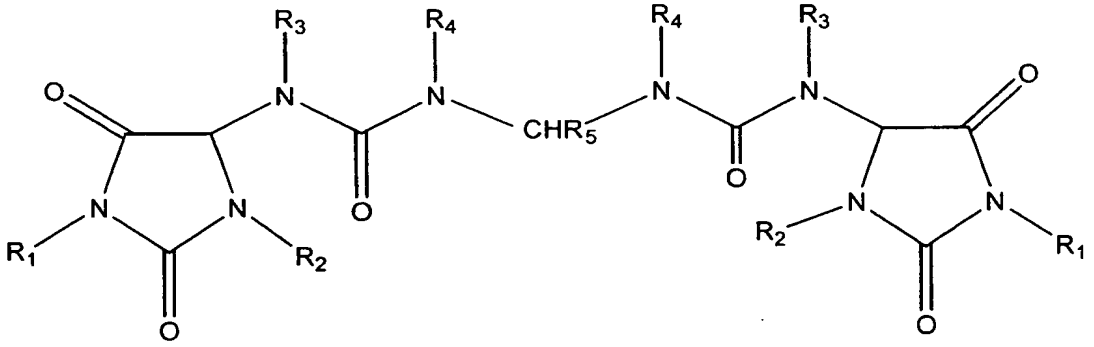
Other compounds include the mono-iodopropynyl esters of anhydrides such as succinic and phthalic as well as the following anhydrides: ethylenediamine tetraacetic dianhydride, 3,3-dimethylglutaric anhydride, S-acetylmercaptosuccinic anhydride, dichloromaleic anhydride, 2-dodecen-1-yl succinic anhydride and cis-5-norbornene-endo-2,3-dicarboxylic anhydride. Where hydrophilicity is desired, the sodium salts may be used because of their extremely high water solubility. Preferred carboxylic acid anhydrides include succinic, itaconic, phthalic, tetrachlorophthalic, and diglycolic anhydride. Such compounds are defined in U.S. Patent 4,844,891 and 5,073,570.

The stabilizers used in the invention are hydantoin and urea and their derivatives, most preferably 5,5-dimethylhydantoin.

Hydantoins and their derivatives may be represented by formulas III, IV, and V:



III



IV

where R_1 to R_4 are independently selected from H, C_1 to C_{22}.

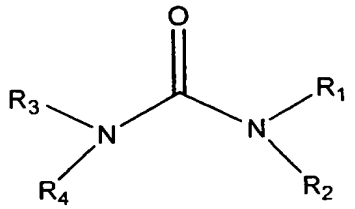
N,N"-Methylenebis[N'-2,5-dioxo-4-imidazolidinyl]urea and its derivatives:

where R_1 to R_5 are independently selected from H or C_1 to C_{22}.

2,5-Dioxo-4-imidazolidinyl urea (5-ureidohydantoin) and its derivatives:

where R_1 to R_7 are independently selected from H, CH_3, C_2H_5 or C_3H_7.

Urea and its derivatives are represented by Formula VI:

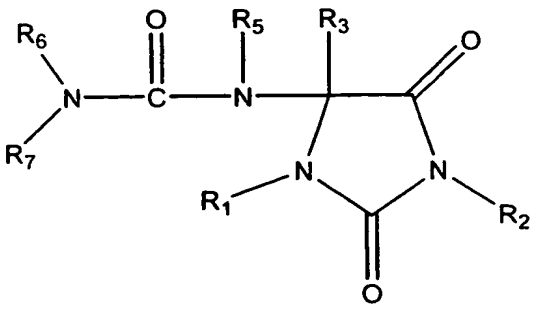


VI

where R_1 to R_4 are independently selected from H or C_1 to C_{12}. Where all the R groups are H, the compound is urea.

The solvents which may be used in the invention include mono-, di-, and polyhydroxyl alcohols. For example, monohydroxyl alcohols having from about 1 to 5 carbon atoms, most preferably ethanol and propanol, may be used. Dihydroxyl alcohols (i.e., glycols) such as C_2 to C_8 diols such as propylene glycol and butylene glycol are advantageous. 1,3-Butylene glycol is particularly preferred. Other compounds which can be used include: dipropylene glycol, glycerin, diglycerin, PPG-9, PPG-2-buteth-2, butoxypropanol, butoxydiglycol, PPG-2 butyl ether, glycereth-7, sorbitol, isopentyldiol, myristyl myristate, and phenoxy ethanol.

The preservative formulations of the instant invention can be readily prepared in accordance with procedures well known to those skilled in the art. The pre-



V

ferred procedure is first to mix the stabilizer at temperatures ranging from 30°C to 50°C with the dialkanol-substituted dimethylhydantoin. This mixture is stirred for 5 minutes at 30°C. It may be heated to 50°C to increase the solution rate. Thereafter the hydroxylic solvent is added and the entire mixture is stirred over a period of 5 minutes. Finally, the iodopropynyl compound is added and mixed for another 15 minutes to form a homogeneous solution. The total mixing time is approximately 30 minutes.

The liquid preservative composition of the invention has a free formaldehyde concentration of less than 1 wt.%, preferably less than 0.2. The total formaldehyde concentration is from 5 wt.% to 25 wt.%, and preferably from 12 wt.% to 14 wt.%.

The preservatives of the invention can be used as active compounds for combating microorganisms, in particular for the preservation of cosmetics, personal care products, household products, and industrial materials such as adhesives, sizes, paper and cardboard, textiles, leather, wood, paints and articles made of plastic, cooling lubricants and other materials which can be attacked or decomposed by microorganisms. Components of production plants, for example cooling water, which can be impaired by multiplication of microorganisms, may also be beneficially treated. Also, the integrity of other water-containing systems, such as swimming pools and spas, can be maintained by use of the preservatives of the invention. In addition, they can be used to control and eliminate microorganisms by disinfection and sanitization of surfaces, such as found in homes, institutions, and hospitals.

Examples of microorganisms which can effect contamination, degradation, or a change in the industrial environments and materials are bacteria, fungi, yeasts, algae, and slime organisms. The active compounds of the invention act against fungi, in particular mold fungi, fungi which discolor and destroy wood (Basidiomycetes), and against slime organisms and algae.

Microorganisms of the following genera are examples: Alternaria, such as *Alternaria tenuis*, Aspergillus, such as *Aspergillus niger*, Chaetomium, such as *Chaetomium globosum*, Candida, such as *Candida albicans*, Lentinus, such as *Lentinus tigrinus*, Penicillium, such as *Penicillium glaucum*, Trichophyton, such as *Trichophyton mentagrophytes*, Aureobasidium, such as *Aureobasidium pullulans*, Enterobacter, such as *Enterobacter gergoviae*, Trichoderma, such as *Trichoderma viride*, Escherichia, such as *Escherichia coli*, Pseudomonas, such as *Pseudomonas aeruginosa* and *Pseudomonas cepacia*, and Staphylococcus, such as *Staphylococcus aureus* and *Staphylococcus epidermidas*.

The use concentrations of the active compounds according to the invention depend on the nature and the occurrence of the microorganisms to be combated, and on the composition of the material to be preserved. The optimum amount to be employed can be determined by means of a series of tests. The use concentrations are in general in the range of 0.00005 (0.5 ppm) to 5% by weight, preferably from 0.0001 to 1%, relative to the material to be preserved.

Liquid compositions of this invention are used directly as they are manufactured without dilution. They may be poured into small batches (from one to thousands of pounds) of product at any point in its manufacture. Also, the liquid compositions may be pumped into medium sized batches (from thousands to tens of thousands of pounds) from a weigh scale.

The preservative of the invention may also be metered continuously from a storage tank into large sized production runs (from tens of thousands to millions of pounds) in systems custom-designed to continuously mix all the components of the finished product at approximately the same rate that it is filled into its final package. The blending elements of continuous mixers are mostly shaped in the form of spirals or screws, effecting on rotation both a mixing and a transport of the product composition.

Because start-up is very labor-intensive, to insure all the metering equipment is properly calibrated, these systems are generally used only for very high volume, long and continuous production runs.

In order to illustrate more fully the subject invention, attention is directed to the following examples:

Example 1

A preservative of the instant invention containing 81 parts of Glydant II (a trademark of Lonza Inc.), 12 parts of dimethylhydantoin, 4.5 parts of butylene glycol, and 2.5 parts of iodopropynyl butyl carbamate is described in this example. Glydant II contains 65% DMDMH, 30% MMDMH, and 5% DMH. It has a total formaldehyde content of 17%.

Initially the DMH and the Glydant II are mixed at 30°C. The mixing continues for 5 minutes during which the temperature is increased to 50°C. Thereafter the butylene glycol is added and stirring is continued for 10 minutes. Finally, the IPBC is added and mixed with the other constituents for 15 minutes to form the final solution. After the mixture is cooled to room temperature, a clear homogeneous liquid solution is obtained. The solution has a total formaldehyde content of 14 wt.%, a free formaldehyde content of 0.05 wt.%, and an IPBC content of 2.3%. After storage for one month at 50°C, the mixture remains a clear, colorless liquid with 92% recovery of the total formaldehyde content and >99% recovery of the IPBC content obtained.

This solution remains clear and colorless even after two months storage at room temperature in sunlight. Significantly, quantitative recovery of total formaldehyde and IPBC is also obtained. Free formaldehyde content is 0.06%.

Example 2

To illustrate the suitability of the liquid preservative of the invention for use in automated liquid blending systems, the viscosity and the specific gravity

of the formulation described in Example 1 are determined. A Brookfield Model RVT viscometer, Spindle No. 3, at 50 rpm is used to determine viscosity. The following results are obtained:

Table 1

Temperature	Specific Gravity	Viscosity, cps
5°C		120
15°C	1.2043	-
25°C	1.1992	40
30°C	1.1960	-
35°C	1.1954	-
45°C		30
65°C	1.1625	20
85°C	1.1500	10

The viscosity values and the specific gravity measurements presented in Table 1 for the liquid preservative of this invention are typical of liquids used in automated blending systems. These ideal parameters are dependent on the particular system employed.

Example 3

To demonstrate the activity of the liquid preservative described in Example 1, 48 hour minimum inhibitory concentration tests were performed on eight bacteria organisms. These tests compared the liquid preservative of the invention to a solid preservative on a 100% active basis. The composition of the solid preservative was 95% DMDMH and 5% IPBC.

The results obtained from the foregoing tests are set forth in Figure 1.

It will be noted that the results obtained for the liquid formulation of the invention, as compared to the solid formulation, are substantially comparable. In certain instances the liquid formulation is superior, as in the case of the *A. baumanii*, the *S. epidermidis*, and the *E. coli*. These data show that the liquid formulations of the invention have a broad spectrum activity against a wide range of bacteria.

Example 4

Minimum inhibitory concentration tests (72 hours) for the liquid preservative described in Example 1 and the solid preservative defined in Example 2 were performed with respect to four fungal organisms. The comparison was made on a 100% active basis.

Figure 2 illustrates that the liquid preservative of the invention is as efficacious as the solid in all of the tests performed and that these materials have broad spectrum activity against a variety of fungi.

Example 5

A series of formulations were prepared to determine the solubility, free formaldehyde concentration, and physical stability of the compositions of the invention as compared to compositions free of dimethylhydantoin. The formulations are shown in Table 2.

Table 2
Liquid Glydant Plus Comparison Chart

Ingredients - %	A 5503-84-1	B 5503-84-2	C 5503-90-1	D 5503-111-1	E 5503-111-2	F 5503-115-1	G 5503-115-2
IPBC (Poly P-100)	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Glydant II	74.70	72.85	74.70	81.00	81.00	81.00	81.00
Prop. Glycol	22.80		12.80	4.50		16.50	4.50
But. Glycol		24.65			4.50		
DMH			10.00	12.00	12.00		
DI Water							12.00
Solubility	OK	OK	OK	OK	OK		No good-ppt.
Physical Solubility	ppt. after 3rd freeze/thaw	OK after 3rd freeze/thaw	OK after 3rd freeze/thaw	OK after 3rd freeze/thaw	OK after 3rd freeze/thaw	ppt. after 3rd freeze/thaw	
% Free HCHO - Initial	0.20	0.24	0.07	0.03	0.05	0.17	
% Free HCHO - 1 month @ 40°C	0.19	0.19	0.19	0.02	0.03		
% Free HCHO - 2 months @ 40°C	0.21	0.25	0.06				
% Free HCHO - 1 month @ 50°C	0.24	0.23	0.11	0.05	0.05		
Comments	Unstable & % free HCHO too high	Stable but % free HCHO too high	Stable & good % free HCHO but % total HCHO not high enough	Stable & low % free HCHO & % total HCHO - OK	Stable & low % free HCHO & total HCHO - OK Going with But. Glycol	Unstable and % free HCHO too high	Insoluble

The above data show that the liquid compositions of the invention, namely, Formulations 90-1, 111-1, and 111-2, had high solubility, good physical stability, and extremely low free formaldehyde as compared to the formulations free of DMH, namely, Formulations 84-1, 84-2, 115-1, and 115-2. Formulations 111-1 and 111-2 are preferred because of the higher total formaldehyde concentration.

Example 5

Using the formulations shown in Table 3, liquid preservatives of the invention were tested to determine the free formaldehyde, total formaldehyde, and percent IPBC after one month stability tests at 40°C and 50°C, respectively. As will be noted, the formulations contained 10, 12, and 15 parts of dimethylhydantoin. Results are set forth in the following table:

Table 3

Chemical Stability Results of the
Preferred Aqueous Liquid Systems of the Invention

Formulation	A 5503- 109-1	B 5503- 109-2	C 5503- 111-1	D 5503- 111-2	E 5503- 111-3
Parts:					
Glydant II	81	81	81	81	81
IPBC	2.5	2.5	2.5	2.5	2.5
Propylene glycol	6.5	-	4.5	-	1.5
Butylene glycol	-	6.5	-	4.5	-
DMH	10	10	12	12	15
% Free HCHO (criterion for Free HCHO is <0.19%)					
Initial	0.05	0.07	0.03	0.05	0.02
40°C Stability 1 Month	0.05	0.05	0.02	0.03	0.03
50°C Stability 1 month	0.07	0.05	0.05	0.05	0.02
% Total HCHO (criterion for Total HCHO is 90% recovery)					

Initial	14.08	14.05	14.07	14.09	14.11
40°C Stability 1 Month	13.04	13.10	12.33	13.16	13.19
50°C Stability 1 Month	12.83	13.07	12.80	12.91	12.84
% Recovery after 50°C Stability	91.0	93.0	91.0	92.0	91.0
% IPBC (criterion for IPBC is 90% recovery)					
Initial	2.41	2.32	2.34	2.28	2.46
40°C Stability 1 Month	2.38	2.38	2.48	2.42	2.43
50°C Stability 1 Month	2.23	2.20	2.24	2.27	2.26
% Recovery after 50°C Stability	93.0	95.0	96.0	99.6	92.0

The above data show that, after one month of storage, the stabilized compositions all had stabilities of over 90%. These data illustrate that butylene glycol is the preferred solvent.

In comparison to a liquid preservative system, without the added stabilizer, DMH, recovery of IPBC after four weeks storage at 45°C was only about 60% and does not meet the criteria of the industries that use preservatives in their products.

Example 6

The composition of the invention described in Example 1 was tested for chemical stability at elevated temperatures and in sunlight in glass and high density polyethylene containers. The compositions were analyzed for percent total formaldehyde, percent free formaldehyde, and percent IPBC after one, two, and three months.

The results are shown in the following table:

Table 4

		1 month		2 months		3 months	
#5503-125	Initial	glass	HDPE	glass	HDPE	glass	HDPE
% Total HCHO	13.02						
RT		13.60	13.40	13.90	12.80	13.11	13.21
40°C		13.40	13.60	13.10	13.10	12.76	12.87
50°C		13.10	13.10	--	--	--	--
Sunlight		13.60	13.60	13.50	13.20	12.95	13.13
Lab light		--	--	--	--	12.93	13.13
% Free HCHO	0.09						
RT		0.05	0.04	0.04	0.04	0.02	0.04
40°C		0.04	0.06	0.06	0.05	0.04	0.06
50°C		0.06	0.05	--	--	--	--
Sunlight		0.05	0.06	0.09	0.06	0.07	0.07
Lab light		--	--	--	--	0.03	0.03
% IPBC	2.49						
RT		2.50	2.50	2.30	2.30	2.30	2.30
40°C		2.49	2.45	2.50	2.50	2.40	2.40
50°C		2.26	2.25	--	--	--	--
Sunlight		2.46	2.49	2.30	2.50	2.30	2.30
Lab light		--	--	--	--	2.30	2.30

The above data clearly show that the composition remains stable under all conditions, i.e., at room temperature, 40°C, and 50°C and in the presence of sunlight and laboratory lighting.

We claim:

1. A broad spectrum liquid preservative formulation comprising from about 20 to 95 parts of a dialkanol-substituted dimethylhydantoin, from about 0.2 to 20 parts of an iodopropynyl compound, from about 1 to 30 parts of a stabilizer for the iodopropynyl compound, and from about 0 to 60 parts of a hydroxyl solvent.

2. The liquid preservative formulation of claim 1 wherein the dialkanol-substituted dimethylhydantoin is 1,3-dimethylol-5,5-dimethylhydantoin, 1-methylol-5,5-dimethylhydantoin, 3-methylol-5,5-dimethylhydantoin, 1,3-dimethylol-oxymethylene-5,5-dimethylhydantoin, 1-methylol-3-methyloloxymethylene-5,5-dimethylhydantoin and 1,3-dimethyloloxymethylene-5,5-dimethylhydantoin, and mixtures thereof.

3. The liquid preservative formulation of claim 1 wherein the dialkanol disubstituted dimethylhydantoin is 1,3-dimethylol-5,5-dimethylhydantoin.

4. The liquid preservative formulation of claim 1 wherein the iodopropynyl compound is 3-iodo-2-propynylbutyl carbamate.

5. The liquid preservative formulation of claim 1 wherein the stabilizer is hydantoin, urea, or a derivative thereof.

6. The liquid preservative formulation of claim 5 wherein the stabilizer is dimethylhydantoin.

7. The liquid preservative formulation of claim 1 wherein the hydroxyl solvent is propylene glycol or butylene glycol.

8. The liquid preservative formulation of claim 6 wherein the ratio of the dimethylhydantoin to the iodopropynyl compound is from 150:1 to 0.05:1.

9. The liquid preservative formulation of claim 1 wherein the free formaldehyde concentration is less than 1% and the total formaldehyde concentration at least 2%.

10. A method of preparing a liquid preservative composition which comprises blending a dialkanol-substituted dimethylhydantoin and a stabilizer of hydantoin, urea or a derivative thereof to form a homogeneous mixture, admixing a hydroxyl solvent and the iodopropynyl compound with the foregoing mixture to obtain a homogeneous solution containing a total formaldehyde content of at least 2% and less than 0.2% free formaldehyde.

11. A stabilized iodopropynyl solution which comprises an iodopropynyl compound and a stabilizing amount of a hydantoin, urea or derivative thereof.

12. The solution of claim 11 wherein the stabilizer is dimethylhydantoin.

13. The solution of claim 11 wherein the iodopropynyl compound is iodo-2-propynylbutyl carbamate.

14. A process for killing or retarding the growth of microbes which comprises admixing the composition of claim 1 in a solution subject to the growth of microbes.

15. The process of claim 14 wherein the composition contains a dialkanol-substituted dimethylhydantoin, a stabilizer of hydantoin, urea or a derivative thereof, a hydroxyl solvent, and an iodopropynyl compound.

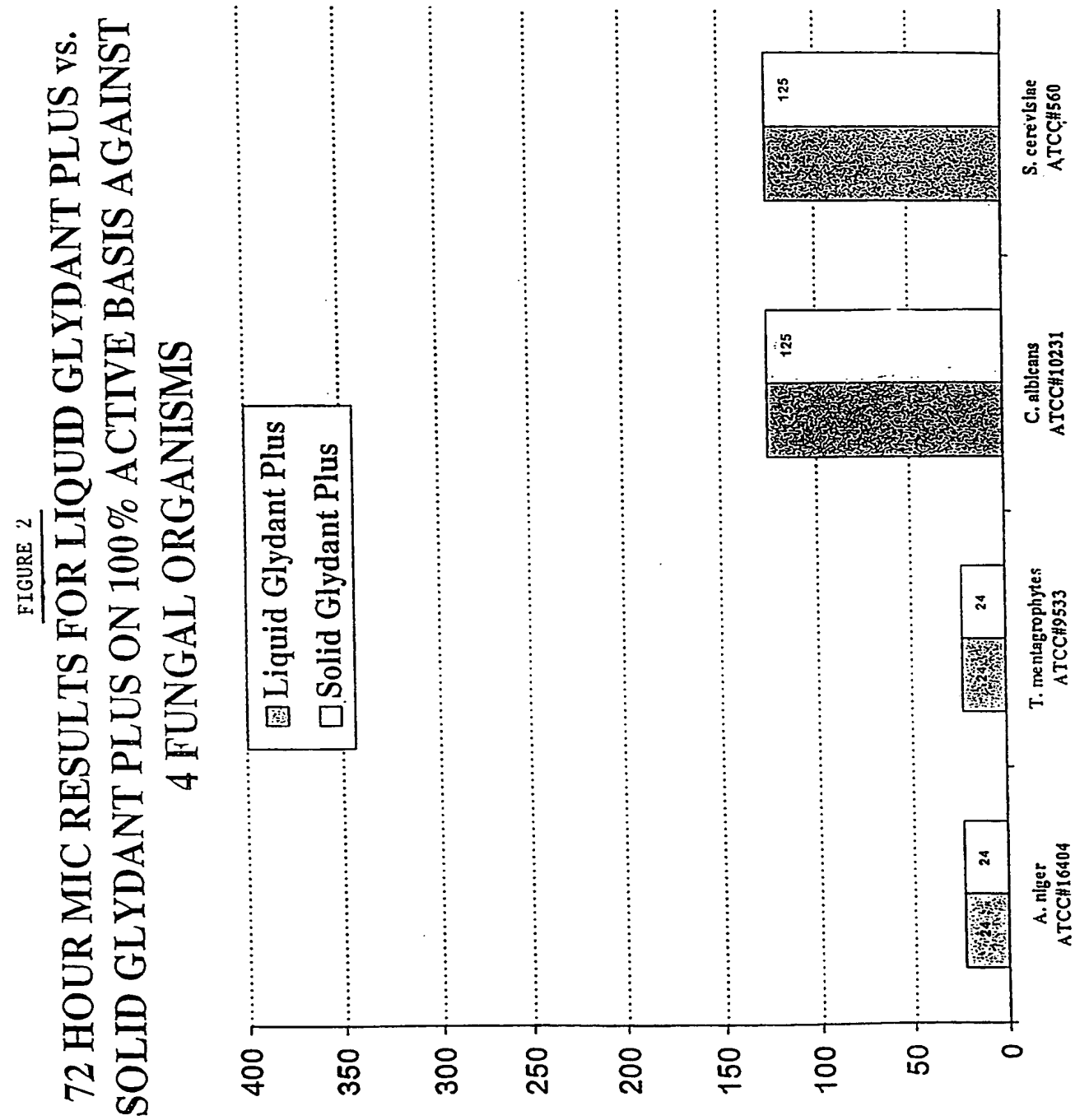
FIGURE 1

48 HOUR MIC RESULTS FOR LIQUID GLYDANT PLUS VS. SOLID GLYDANT PLUS ON 100% ACTIVE BASIS AGAINST 8 BACTERIA ORGANISMS

AS FILED 6/19/98

FIGURE 2

72 HOUR MIC RESULTS FOR LIQUID GLYDANT PLUS vs. SOLID GLYDANT PLUS ON 100% ACTIVE BASIS AGAINST 4 FUNGAL ORGANISMS



INTERNATIONAL SEARCH REPORT

Intr tional Application No
PCT/US 99/14171

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A01N47/12 //(A01N47/12,43:50,25:22)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 199834 Derwent Publications Ltd., London, GB; Class D22, AN 1998-393347 XP002118218 & JP 10 158110 A (MITSUI TOATSU CHEM INC), 16 June 1998 (1998-06-16) abstract & PATENT ABSTRACTS OF JAPAN vol. 199, no. 811, 30 September 1998 (1998-09-30) & JP 10 158110 A abstract	11,13
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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(54) Title: STABILIZED MIXTURES OF AN IODOPROPARGYL COMPOUND AND A FORMALDEHYDE DONOR

(57) Abstract

A highly stable liquid formulation having broad spectrum preservative properties which constitutes an admixture of a dialkanol–substituted DMH, an iodopropynyl compound, a stabilizer of a hydantoin, urea or derivative thereof, and a hydroxyl solvent. Preferably the constituents are dimethyloldimethylhydantoin, 3–iodo–2–propynylbutyl carbamate, dimethylhydantoin, and a glycol solvent. The preservative preferably has a total formaldehyde content of 5 % and less than 0.2 % of free formaldehyde. The composition is prepared by successively admixing the dialkanol–substituted dimethylhydantoin and the stabilizer, the hydroxyl solvent, and the iodopropynyl compound. Also described is a stabilized iodopropynyl compound preferably containing dimethylhydantoin as the stabilizer.

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STABILIZED MIXTURES OF AN IODOPROPARGYL COMPOUND AND A FORMALDEHYDE DONOR

Background of the Invention

The need for effective and economical preservative compositions is well known. There are a wide variety of applications where inhibiting the growth of microorganisms is necessary, as for example personal care products such as shampoos, creams, lotions, cosmetics, soap and household products such as laundry detergents, hard surface cleaners, and fabric softeners. The shelf life of these preparations depends on their resistance to microbial spoilage.

In addition, in many industrial applications, antimicrobial agents are useful in paint, wood, textiles, adhesives, sealants, leather, rope, paper pulp, plastics, fuel, oil, and rubber and metal working fluids. The control of slime-producing bacteria and fungi in pulp and paper mills and cooling towers is a matter of substantial commercial importance.

For the foregoing applications the demand for stable broad-spectrum preservatives has increased. In recent years, these needs have been met with solid formulations. For example, combinations of formaldehyde donors (e.g., dimethyloldimethylhydantoin (DMDMH)) and halopropynyl compounds (e.g., 3-iodo-2-propynylbutyl carbamate (IPBC)) have achieved considerable commercial success. Such synergistic combinations have been described in U.S. Patent 4,844,891.

Furthermore, because of the demand of governmental regulations, low free-formaldehyde products are needed. Research in this area has also proved beneficial. For example, in the case of DMDMH, improved formulation and

processing has resulted in compositions which contain less than 0.1% free formaldehyde. (See U.S. Patent 5,405,862.) In contrast, earlier formulations of DMDMH had over 1% of free formaldehyde. (See U.S. Patent 3,987,184.)

At the present time, in addition to meeting the above criteria, the industry is demanding liquid forms of preservatives as the use of automatic liquid blending systems becomes more popular. Unfortunately, preservatives that are in liquid form, highly stable, broad spectrum, and low in free formaldehyde have eluded formulators.

Summary of the Invention

It has now been discovered that highly stable, liquid formulations of broad spectrum preservatives can be prepared by admixing alkanol-substituted dimethylhydantoins, iodopropynyl compounds, stabilizers, and a solvent. This invention is based, in part, on the unexpected finding that the iodopropynyl compounds can be stabilized at high temperatures by the addition of hydantoin-type stabilizers such as dimethylhydantoin. Furthermore, the compositions of the invention have surprisingly good physical stability at low temperatures and enhanced solubility which allows the easy preparation of these highly concentrated mixtures. Such highly concentrated preservatives useful in automatic liquid blending systems could not heretofore be prepared.

Brief Description of the Figures

Figure 1 illustrates the results of a 48 hour minimum inhibitory concentration test against 8 bacteria organisms of the liquid formulation of the invention and a solid formulation of DMDMH and IPBC.

Figure 2 illustrates the results of a 72 hour minimum inhibitory concentration test against 4 fungal organisms of the liquid formulation of the invention and a solid formulation of DMDMH and IPBC.

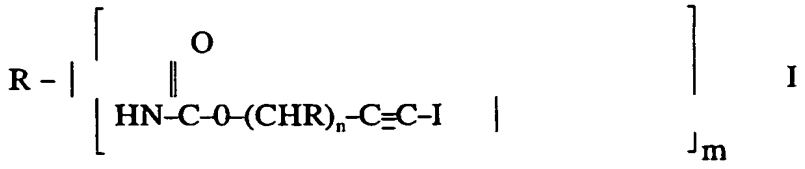
Detailed Description of the Invention

	Broad wt.%	Preferred wt.%
Dialkanol-substituted DMH	20-95%	75-85%
Iodopropynyl Compound	0.2-20	1-5
Stabilizer	1-30	5-20
Hydroxyl Solvent	0-60	2-20

The ratio of the stabilizer to the iodopropynyl compound may broadly be from about 150:1 to 0.05:1, preferably from 20:1 to 1:1, most desirably from about 10:1 to 2:1.

The alkanol-substituted DMH compounds used in the invention are well known and include those defined in U.S. Patent Nos. 3,987,184 and 4,172,140, the entire contents of which are incorporated herein by reference. These are condensation products of 5,5-dimethylhydantoin with 1, 2, or more moles of formaldehyde (e.g., 1,3-dimethylol-5,5-dimethylhydantoin, 1-methylol-5,5-dimethylhydantoin, or 3-methylol-5,5-dimethylhydantoin, 1,3-dimethylol-oxymethylene-5,5-dimethylhydantoin, 1-methylol-3-methyloloxymethylene-5,5-dimethylhydantoin and 1,3-dimethyloloxymethylene-5,5-dimethylhydantoin, and mixtures thereof).

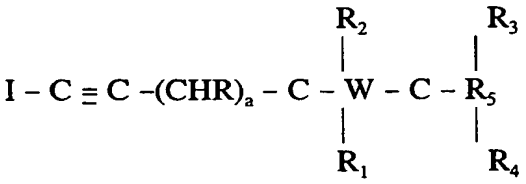
Examples of compounds which may be used as the iodopropynyl component of the invention are the fungicidally active iodopropynyl derivatives. These include compounds derived from propynyl or iodopropynyl alcohols such as the esters, ethers, acetals, carbamates and carbonates and the iodopropynyl derivatives of pyrimidines, triazolinones, tetrazoles, triazinones, sulfamides, benzothiazoles, ammonium salts, carboxamides, hydroxamates, and ureas. Preferred among these compounds is 3-iodo-2-propynylbutyl carbamate, IPBC. These compounds are included within the broadly useful class of compounds having the generic formulas such as I and II shown below:



wherein:

R is selected from the group consisting of substituted and unsubstituted alkyl, aryl, and alkylaryl groups having from 1 to 20 carbon atoms; and

m and n are independent integers from 1 to 3.



wherein:

R_1 and R_2 are defined as R_3 and R_4 below or are joined to form a cycloalkyl, cycloalkenyl, aromatic or a heterocyclic ring containing an oxygen, nitrogen or sulfur atom or an alkoxy, amino, carbonyl, carboxyl, halo, hydroxyl, keto or a thiocarboxyl-substituted derivative thereof;

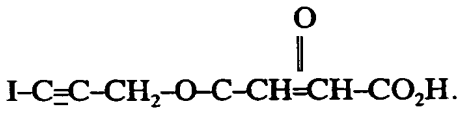
R_3, R_4 and R_5 are independently selected from (A) hydrogen, alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl, a heterocyclic ring containing an oxygen, nitrogen or sulfur atom, alkoxy, amino, carbonyl, carboxyl, halo, hydroxyl, keto or a thiocarboxyl and (B) substituted derivatives of the alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl and the heterocyclic ring wherein the substitutions are alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl, alkoxy, amino, carboxyl, halo, hydroxyl, keto or a thiocarboxyl;

a is 0 to 16;

W may be a single bond, oxygen, NR_6, or $(CR_7R_8)_m$, wherein R_6 is hydrogen, alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl or a heterocyclic ring containing an oxygen, nitrogen or sulfur atom or a substituted derivative of alkyl, cycloalkyl, alkenyl, cycloalkenyl or aryl groups wherein the substitutions are alkyl, cycloalkyl, alkenyl, cycloalkenyl, aryl, alkoxy, amino, carbonyl, carboxyl, halo, hydroxyl, keto, or a thiocarboxyl wherein R_6, R_7 and R_8 are defined as R_3 and R_4 above and m is an integer from 1 to 12. The above definition of R_6 includes, among other things, an aminoalkyl group.

The heterocyclic rings referred to in the above definitions may contain from 5 to 8 members, the alkyl or cycloalkyl groups from 1 to 18 atoms, the alkenyl or cycloalkenyl groups from 2 to 18 carbon atoms, and the aryl groups from 6 to 10 members.

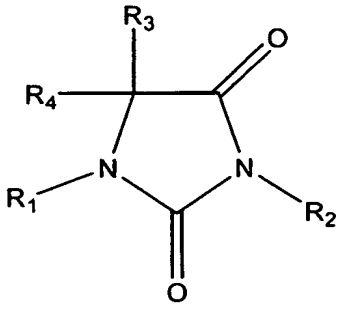
In formula II, when R_1 and R_2 are hydrogen, R_3 and R_4 are carbonyl, R_5 is -CH=CH-CO_2H; a is equal to 0; and W is oxygen, the compound is iodopropynyl maleate,



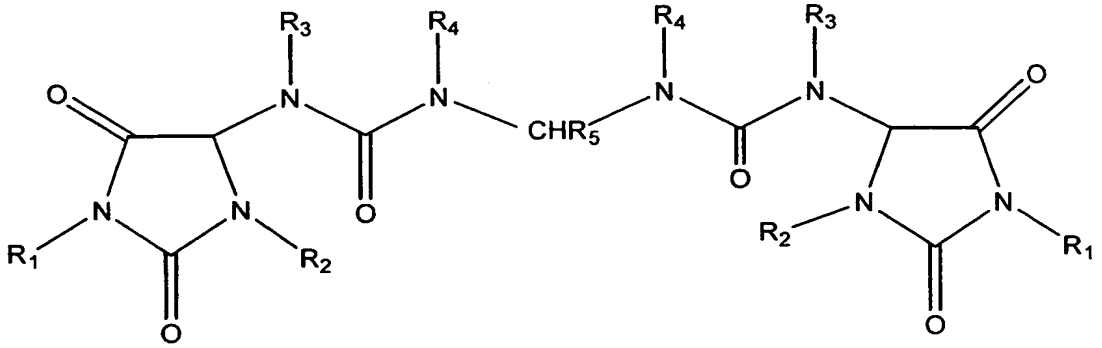
Other compounds include the mono-iodopropynyl esters of anhydrides such as succinic and phthalic as well as the following anhydrides: ethylenediamine tetraacetic dianhydride, 3,3-dimethylglutaric anhydride, S-acetylmercaptosuccinic anhydride, dichloromaleic anhydride, 2-dodecen-1-yl succinic anhydride and cis-5-norbornene-endo-2,3-dicarboxylic anhydride. Where hydrophilicity is desired, the sodium salts may be used because of their extremely high water solubility. Preferred carboxylic acid anhydrides include succinic, itaconic, phthalic, tetrachlorophthalic, and diglycolic anhydride. Such compounds are defined in U.S. Patent 4,844,891 and 5,073,570.

The stabilizers used in the invention are hydantoin and urea and their derivatives, most preferably 5,5-dimethylhydantoin.

Hydantoins and their derivatives may be represented by formulas III, IV, and V:



III



IV

where R_1 to R_4 are independently selected from H, C_1 to C_{22}.

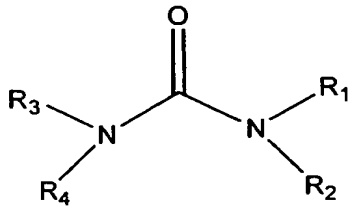
N,N"-Methylenebis[N'-2,5-dioxo-4-imidazolidinyl]urea and its derivatives:

where R_1 to R_5 are independently selected from H or C_1 to C_{22}.

2,5-Dioxo-4-imidazolidinyl urea (5-ureidohydantoin) and its derivatives:

where R_1 to R_7 are independently selected from H, CH_3, C_2H_5 or C_3H_7.

Urea and its derivatives are represented by Formula VI:

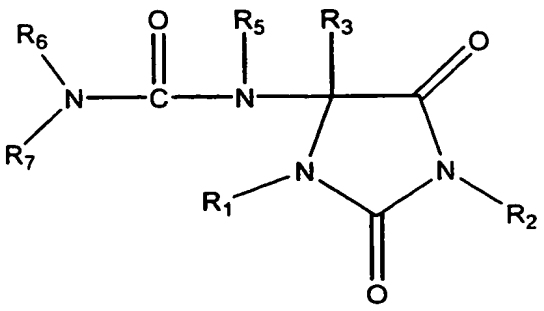


VI

where R_1 to R_4 are independently selected from H or C_1 to C_{12}. Where all the R groups are H, the compound is urea.

The solvents which may be used in the invention include mono-, di-, and polyhydroxyl alcohols. For example, monohydroxyl alcohols having from about 1 to 5 carbon atoms, most preferably ethanol and propanol, may be used. Dihydroxyl alcohols (i.e., glycols) such as C_2 to C_8 diols such as propylene glycol and butylene glycol are advantageous. 1,3-Butylene glycol is particularly preferred. Other compounds which can be used include: dipropylene glycol, glycerin, diglycerin, PPG-9, PPG-2-buteth-2, butoxypropanol, butoxydiglycol, PPG-2 butyl ether, glycereth-7, sorbitol, isopentyldiol, myristyl myristate, and phenoxy ethanol.

The preservative formulations of the instant invention can be readily prepared in accordance with procedures well known to those skilled in the art. The pre-



V

ferred procedure is first to mix the stabilizer at temperatures ranging from 30°C to 50°C with the dialkanol-substituted dimethylhydantoin. This mixture is stirred for 5 minutes at 30°C. It may be heated to 50°C to increase the solution rate. Thereafter the hydroxylic solvent is added and the entire mixture is stirred over a period of 5 minutes. Finally, the iodopropynyl compound is added and mixed for another 15 minutes to form a homogeneous solution. The total mixing time is approximately 30 minutes.

The liquid preservative composition of the invention has a free formaldehyde concentration of less than 1 wt.%, preferably less than 0.2. The total formaldehyde concentration is from 5 wt.% to 25 wt.%, and preferably from 12 wt.% to 14 wt.%.

The preservatives of the invention can be used as active compounds for combating microorganisms, in particular for the preservation of cosmetics, personal care products, household products, and industrial materials such as adhesives, sizes, paper and cardboard, textiles, leather, wood, paints and articles made of plastic, cooling lubricants and other materials which can be attacked or decomposed by microorganisms. Components of production plants, for example cooling water, which can be impaired by multiplication of microorganisms, may also be beneficially treated. Also, the integrity of other water-containing systems, such as swimming pools and spas, can be maintained by use of the preservatives of the invention. In addition, they can be used to control and eliminate microorganisms by disinfection and sanitization of surfaces, such as found in homes, institutions, and hospitals.

Examples of microorganisms which can effect contamination, degradation, or a change in the industrial environments and materials are bacteria, fungi, yeasts, algae, and slime organisms. The active compounds of the invention act against fungi, in particular mold fungi, fungi which discolor and destroy wood (Basidiomycetes), and against slime organisms and algae.

Microorganisms of the following genera are examples: Alternaria, such as *Alternaria tenuis*, Aspergillus, such as *Aspergillus niger*, Chaetomium, such as *Chaetomium globosum*, Candida, such as *Candida albicans*, Lentinus, such as *Lentinus tigrinus*, Penicillium, such as *Penicillium glaucum*, Trichophyton, such as *Trichophyton mentagrophytes*, Aureobasidium, such as *Aureobasidium pullulans*, Enterobacter, such as *Enterobacter gergoviae*, Trichoderma, such as *Trichoderma viride*, Escherichia, such as *Escherichia coli*, Pseudomonas, such as *Pseudomonas aeruginosa* and *Pseudomonas cepacia*, and Staphylococcus, such as *Staphylococcus aureus* and *Staphylococcus epidermidas*.

The use concentrations of the active compounds according to the invention depend on the nature and the occurrence of the microorganisms to be combated, and on the composition of the material to be preserved. The optimum amount to be employed can be determined by means of a series of tests. The use concentrations are in general in the range of 0.00005 (0.5 ppm) to 5% by weight, preferably from 0.0001 to 1%, relative to the material to be preserved.

Liquid compositions of this invention are used directly as they are manufactured without dilution. They may be poured into small batches (from one to thousands of pounds) of product at any point in its manufacture. Also, the liquid compositions may be pumped into medium sized batches (from thousands to tens of thousands of pounds) from a weigh scale.

The preservative of the invention may also be metered continuously from a storage tank into large sized production runs (from tens of thousands to millions of pounds) in systems custom-designed to continuously mix all the components of the finished product at approximately the same rate that it is filled into its final package. The blending elements of continuous mixers are mostly shaped in the form of spirals or screws, effecting on rotation both a mixing and a transport of the product composition.

Because start-up is very labor-intensive, to insure all the metering equipment is properly calibrated, these systems are generally used only for very high volume, long and continuous production runs.

In order to illustrate more fully the subject invention, attention is directed to the following examples:

Example 1

A preservative of the instant invention containing 81 parts of Glydant II (a trademark of Lonza Inc.), 12 parts of dimethylhydantoin, 4.5 parts of butylene glycol, and 2.5 parts of iodopropynyl butyl carbamate is described in this example. Glydant II contains 65% DMDMH, 30% MMDMH, and 5% DMH. It has a total formaldehyde content of 17%.

Initially the DMH and the Glydant II are mixed at 30°C. The mixing continues for 5 minutes during which the temperature is increased to 50°C. Thereafter the butylene glycol is added and stirring is continued for 10 minutes. Finally, the IPBC is added and mixed with the other constituents for 15 minutes to form the final solution. After the mixture is cooled to room temperature, a clear homogeneous liquid solution is obtained. The solution has a total formaldehyde content of 14 wt.%, a free formaldehyde content of 0.05 wt.%, and an IPBC content of 2.3%. After storage for one month at 50°C, the mixture remains a clear, colorless liquid with 92% recovery of the total formaldehyde content and >99% recovery of the IPBC content obtained.

This solution remains clear and colorless even after two months storage at room temperature in sunlight. Significantly, quantitative recovery of total formaldehyde and IPBC is also obtained. Free formaldehyde content is 0.06%.

Example 2

To illustrate the suitability of the liquid preservative of the invention for use in automated liquid blending systems, the viscosity and the specific gravity

of the formulation described in Example 1 are determined. A Brookfield Model RVT viscometer, Spindle No. 3, at 50 rpm is used to determine viscosity. The following results are obtained:

Table 1

Temperature	Specific Gravity	Viscosity, cps
5°C		120
15°C	1.2043	-
25°C	1.1992	40
30°C	1.1960	-
35°C	1.1954	-
45°C		30
65°C	1.1625	20
85°C	1.1500	10

The viscosity values and the specific gravity measurements presented in Table 1 for the liquid preservative of this invention are typical of liquids used in automated blending systems. These ideal parameters are dependent on the particular system employed.

Example 3

To demonstrate the activity of the liquid preservative described in Example 1, 48 hour minimum inhibitory concentration tests were performed on eight bacteria organisms. These tests compared the liquid preservative of the invention to a solid preservative on a 100% active basis. The composition of the solid preservative was 95% DMDMH and 5% IPBC.

The results obtained from the foregoing tests are set forth in Figure 1.

It will be noted that the results obtained for the liquid formulation of the invention, as compared to the solid formulation, are substantially comparable. In certain instances the liquid formulation is superior, as in the case of the *A. baumanii*, the *S. epidermidis*, and the *E. coli*. These data show that the liquid formulations of the invention have a broad spectrum activity against a wide range of bacteria.

Example 4

Minimum inhibitory concentration tests (72 hours) for the liquid preservative described in Example 1 and the solid preservative defined in Example 2 were performed with respect to four fungal organisms. The comparison was made on a 100% active basis.

Figure 2 illustrates that the liquid preservative of the invention is as efficacious as the solid in all of the tests performed and that these materials have broad spectrum activity against a variety of fungi.

Example 5

A series of formulations were prepared to determine the solubility, free formaldehyde concentration, and physical stability of the compositions of the invention as compared to compositions free of dimethylhydantoin. The formulations are shown in Table 2.

Table 2
Liquid Glydant Plus Comparison Chart

Ingredients - %	A 5503-84-1	B 5503-84-2	C 5503-90-1	D 5503-111-1	E 5503-111-2	F 5503-115-1	G 5503-115-2
IPBC (Poly P-100)	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Glydant II	74.70	72.85	74.70	81.00	81.00	81.00	81.00
Prop. Glycol	22.80		12.80	4.50		16.50	4.50
But. Glycol		24.65			4.50		
DMH			10.00	12.00	12.00		
DI Water							12.00
Solubility	OK	OK	OK	OK	OK		No good-ppt.
Physical Solubility	ppt. after 3rd freeze/thaw	OK after 3rd freeze/thaw	OK after 3rd freeze/thaw	OK after 3rd freeze/thaw	OK after 3rd freeze/thaw	ppt. after 3rd freeze/thaw	
% Free HCHO - Initial	0.20	0.24	0.07	0.03	0.05	0.17	
% Free HCHO - 1 month @ 40°C	0.19	0.19	0.19	0.02	0.03		
% Free HCHO - 2 months @ 40°C	0.21	0.25	0.06				
% Free HCHO - 1 month @ 50°C	0.24	0.23	0.11	0.05	0.05		
Comments	Unstable & % free HCHO too high	Stable but % free HCHO too high	Stable & good % free HCHO but % total HCHO not high enough	Stable & low % free HCHO & % total HCHO - OK	Stable & low % free HCHO & total HCHO - OK Going with But. Glycol	Unstable and % free HCHO too high	Insoluble

The above data show that the liquid compositions of the invention, namely, Formulations 90-1, 111-1, and 111-2, had high solubility, good physical stability, and extremely low free formaldehyde as compared to the formulations free of DMH, namely, Formulations 84-1, 84-2, 115-1, and 115-2. Formulations 111-1 and 111-2 are preferred because of the higher total formaldehyde concentration.

Example 5

Using the formulations shown in Table 3, liquid preservatives of the invention were tested to determine the free formaldehyde, total formaldehyde, and percent IPBC after one month stability tests at 40°C and 50°C, respectively. As will be noted, the formulations contained 10, 12, and 15 parts of dimethylhydantoin. Results are set forth in the following table:

Table 3

Chemical Stability Results of the
Preferred Aqueous Liquid Systems of the Invention

Formulation	A 5503- 109-1	B 5503- 109-2	C 5503- 111-1	D 5503- 111-2	E 5503- 111-3
Parts:					
Glydant II	81	81	81	81	81
IPBC	2.5	2.5	2.5	2.5	2.5
Propylene glycol	6.5	-	4.5	-	1.5
Butylene glycol	-	6.5	-	4.5	-
DMH	10	10	12	12	15
% Free HCHO (criterion for Free HCHO is <0.19%)					
Initial	0.05	0.07	0.03	0.05	0.02
40°C Stability 1 Month	0.05	0.05	0.02	0.03	0.03
50°C Stability 1 month	0.07	0.05	0.05	0.05	0.02
% Total HCHO (criterion for Total HCHO is 90% recovery)					

Initial	14.08	14.05	14.07	14.09	14.11
40°C Stability 1 Month	13.04	13.10	12.33	13.16	13.19
50°C Stability 1 Month	12.83	13.07	12.80	12.91	12.84
% Recovery after 50°C Stability	91.0	93.0	91.0	92.0	91.0
% IPBC (criterion for IPBC is 90% recovery)					
Initial	2.41	2.32	2.34	2.28	2.46
40°C Stability 1 Month	2.38	2.38	2.48	2.42	2.43
50°C Stability 1 Month	2.23	2.20	2.24	2.27	2.26
% Recovery after 50°C Stability	93.0	95.0	96.0	99.6	92.0

The above data show that, after one month of storage, the stabilized compositions all had stabilities of over 90%. These data illustrate that butylene glycol is the preferred solvent.

In comparison to a liquid preservative system, without the added stabilizer, DMH, recovery of IPBC after four weeks storage at 45°C was only about 60% and does not meet the criteria of the industries that use preservatives in their products.

Example 6

The composition of the invention described in Example 1 was tested for chemical stability at elevated temperatures and in sunlight in glass and high density polyethylene containers. The compositions were analyzed for percent total formaldehyde, percent free formaldehyde, and percent IPBC after one, two, and three months.

The results are shown in the following table:

Table 4

		1 month		2 months		3 months	
#5503-125	Initial	glass	HDPE	glass	HDPE	glass	HDPE
% Total HCHO	13.02						
RT		13.60	13.40	13.90	12.80	13.11	13.21
40°C		13.40	13.60	13.10	13.10	12.76	12.87
50°C		13.10	13.10	--	--	--	--
Sunlight		13.60	13.60	13.50	13.20	12.95	13.13
Lab light		--	--	--	--	12.93	13.13
% Free HCHO	0.09						
RT		0.05	0.04	0.04	0.04	0.02	0.04
40°C		0.04	0.06	0.06	0.05	0.04	0.06
50°C		0.06	0.05	--	--	--	--
Sunlight		0.05	0.06	0.09	0.06	0.07	0.07
Lab light		--	--	--	--	0.03	0.03
% IPBC	2.49						
RT		2.50	2.50	2.30	2.30	2.30	2.30
40°C		2.49	2.45	2.50	2.50	2.40	2.40
50°C		2.26	2.25	--	--	--	--
Sunlight		2.46	2.49	2.30	2.50	2.30	2.30
Lab light		--	--	--	--	2.30	2.30

The above data clearly show that the composition remains stable under all conditions, i.e., at room temperature, 40°C, and 50°C and in the presence of sunlight and laboratory lighting.

We claim:

1. A broad spectrum liquid preservative formulation comprising from about 20 to 95 parts of a dialkanol-substituted dimethylhydantoin, from about 0.2 to 20 parts of an iodopropynyl compound, from about 1 to 30 parts of a stabilizer for the iodopropynyl compound, and from about 0 to 60 parts of a hydroxyl solvent.

2. The liquid preservative formulation of claim 1 wherein the dialkanol-substituted dimethylhydantoin is 1,3-dimethylol-5,5-dimethylhydantoin, 1-methylol-5,5-dimethylhydantoin, 3-methylol-5,5-dimethylhydantoin, 1,3-dimethylol-oxymethylene-5,5-dimethylhydantoin, 1-methylol-3-methyloloxymethylene-5,5-dimethylhydantoin and 1,3-dimethyloloxymethylene-5,5-dimethylhydantoin, and mixtures thereof.

3. The liquid preservative formulation of claim 1 wherein the dialkanol disubstituted dimethylhydantoin is 1,3-dimethylol-5,5-dimethylhydantoin.

4. The liquid preservative formulation of claim 1 wherein the iodopropynyl compound is 3-iodo-2-propynylbutyl carbamate.

5. The liquid preservative formulation of claim 1 wherein the stabilizer is hydantoin, urea, or a derivative thereof.

6. The liquid preservative formulation of claim 5 wherein the stabilizer is dimethylhydantoin.

7. The liquid preservative formulation of claim 1 wherein the hydroxyl solvent is propylene glycol or butylene glycol.

8. The liquid preservative formulation of claim 6 wherein the ratio of the dimethylhydantoin to the iodopropynyl compound is from 150:1 to 0.05:1.

9. The liquid preservative formulation of claim 1 wherein the free formaldehyde concentration is less than 1% and the total formaldehyde concentration at least 2%.

10. A method of preparing a liquid preservative composition which comprises blending a dialkanol-substituted dimethylhydantoin and a stabilizer of hydantoin, urea or a derivative thereof to form a homogeneous mixture, admixing a hydroxyl solvent and the iodopropynyl compound with the foregoing mixture to obtain a homogeneous solution containing a total formaldehyde content of at least 2% and less than 0.2% free formaldehyde.

11. A stabilized iodopropynyl solution which comprises an iodopropynyl compound and a stabilizing amount of a hydantoin, urea or derivative thereof.

12. The solution of claim 11 wherein the stabilizer is dimethylhydantoin.

13. The solution of claim 11 wherein the iodopropynyl compound is iodo-2-propynylbutyl carbamate.

14. A process for killing or retarding the growth of microbes which comprises admixing the composition of claim 1 in a solution subject to the growth of microbes.

15. The process of claim 14 wherein the composition contains a dialkanol-substituted dimethylhydantoin, a stabilizer of hydantoin, urea or a derivative thereof, a hydroxyl solvent, and an iodopropynyl compound.

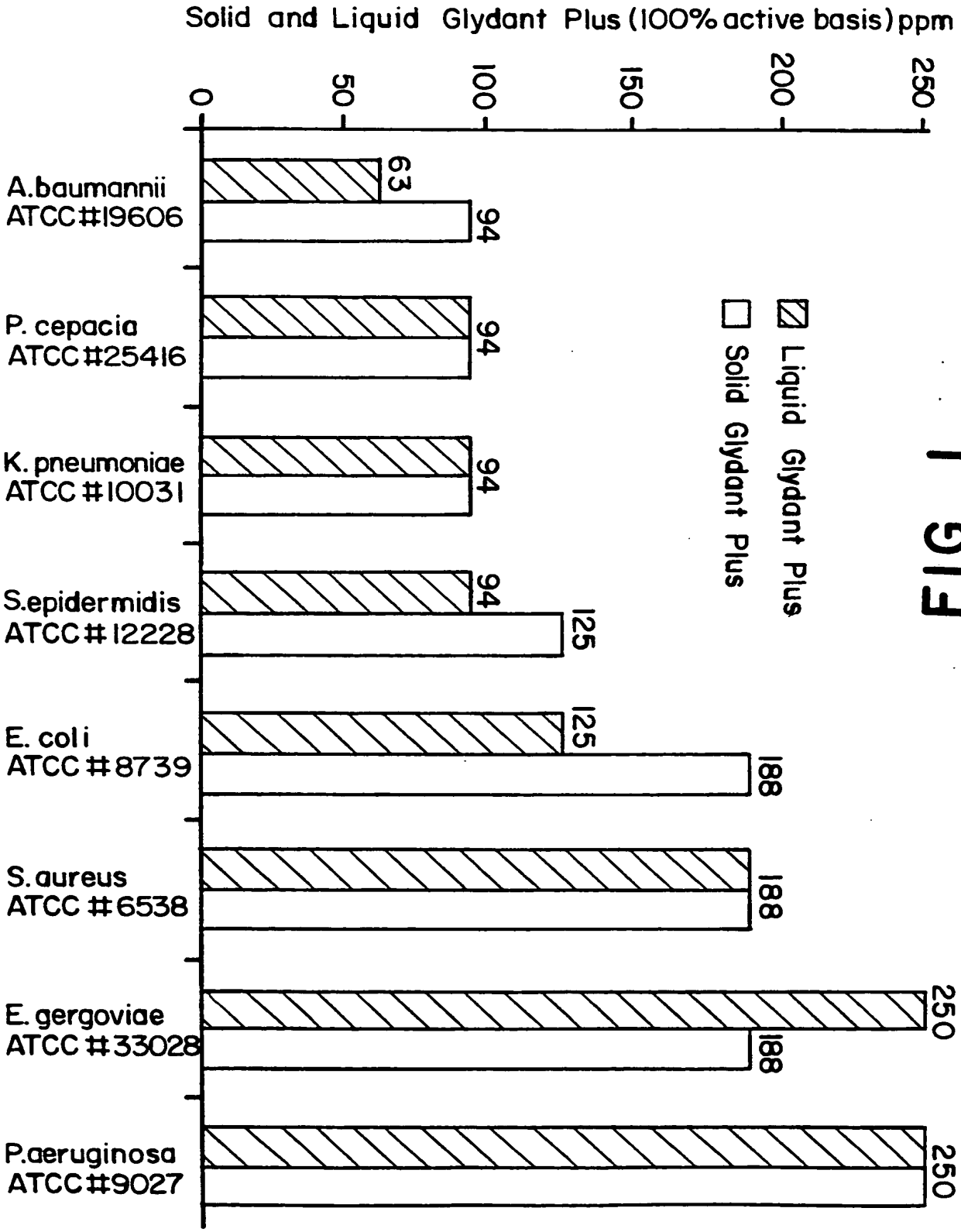
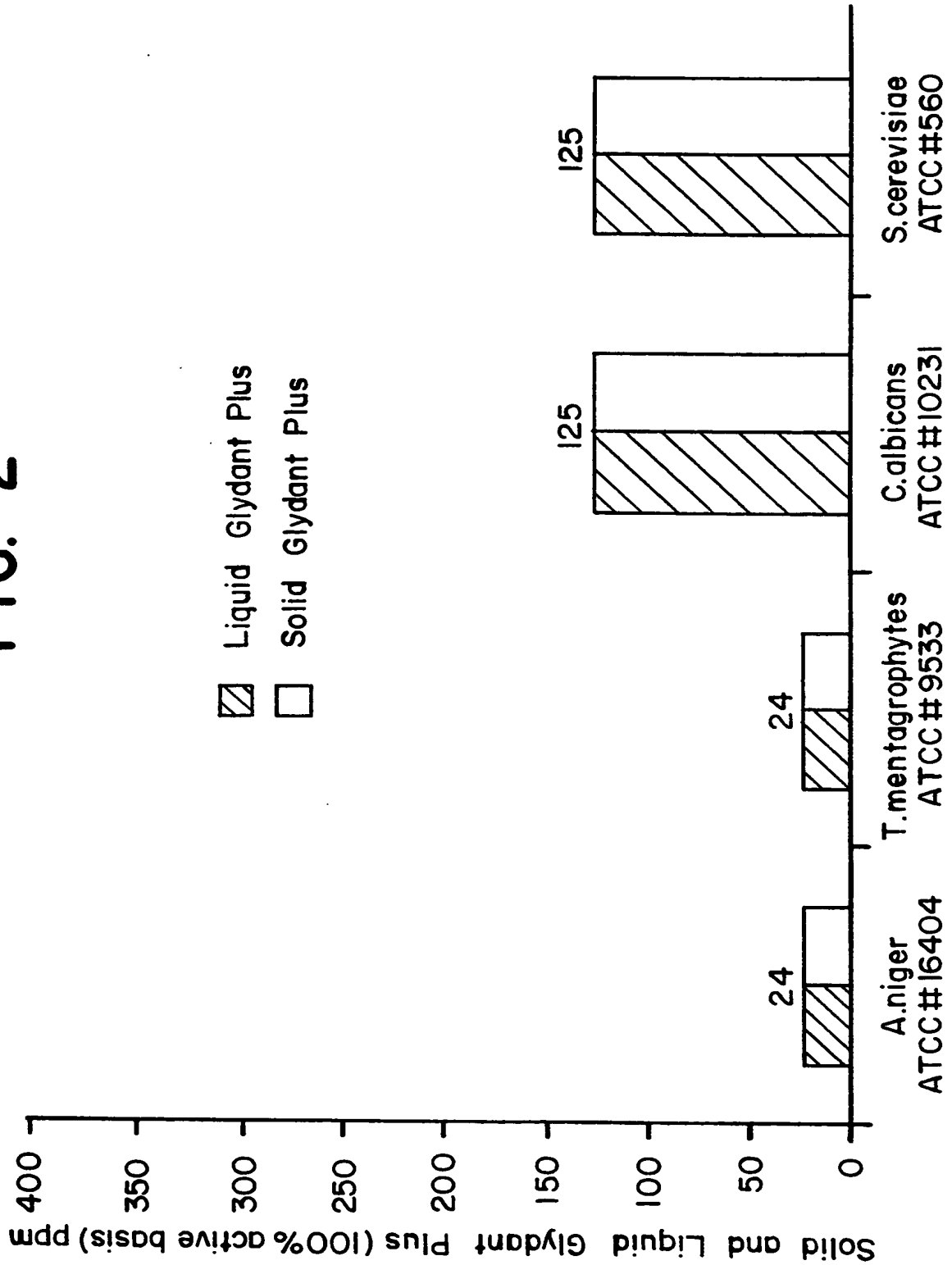


FIG. 1

FIG. 2



INTERNATIONAL SEARCH REPORT

Intr tional Application No
PCT/US 99/14171

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A01N47/12 //(A01N47/12,43:50,25:22)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	WO 95 29588 A (ISP CHEMICALS INC) 9 November 1995 (1995-11-09) page 3, paragraph 3 -page 5, paragraph 1	1-15

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
8 October 1999	18/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lamers, W

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INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/US 99/14171

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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FIGURE 1

48 HOUR MIC RESULTS FOR LIQUID GLYDANT PLUS VS. SOLID GLYDANT PLUS ON 100% ACTIVE BASIS AGAINST 8 BACTERIA ORGANISMS

AS FILED

FIGURE 2

72 HOUR MIC RESULTS FOR LIQUID GLYDANT PLUS vs. SOLID GLYDANT PLUS ON 100% ACTIVE BASIS AGAINST 4 FUNGAL ORGANISMS